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(54) Title: DISPOSAL OF PLASTIC WASTE MATERIAL			
(57) Abstract			
<p>A process for disposing of plastic waste comprising mixing said waste from a holding vessel (10) with a highly aromatic furfural extract phase (12) thus dissolving the plastic in a highly aromatic furfural extract phase (12) in the holding vessel (10) thus forming a solution (14) which is fed to the main fractionator tower (16) of a conventional refinery coker operation and then subjecting the solution to delayed coking.</p>			

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-1-

DISPOSAL OF PLASTIC WASTE MATERIAL

This invention relates to the disposal of waste plastic material.

It is well known that one of the environmental problems facing the world today concerns the disposal of waste plastic material, including hydrocarbon polymers, like polyolefins and polystyrene. The very reason that plastic materials are desirable articles of commerce is also the reason that these materials are difficult to dispose of. Plastics, particularly hydrocarbon polymers, are very useful because they are substantially inert, do not readily decompose and hold their shape, character and color almost indefinitely. While these are all very desirable traits in plastic products, they cause difficulties in disposing of these products after they have completed their intended use.

Much effort has recently gone into various schemes for recycling plastic materials to make other useful products. In much of the plastics industry, this is not a new effort. It is simply uneconomical to "throw out" plastic scrap. Thus, it is common for scrap plastic materials to be recycled to make more of the thing which created the scrap in the first place. For example, plastic bottles can often be collected, mixed with some proportion of fresh plastic material, and remolded into other plastic bottles. Edge trimmings and scrim from moldings can be recycled in admixture with fresh feed to make more plastic moldings.

This works well, but there are still plastic materials which are difficult to apply to this type of use. There is still needed a means to convert plastic materials in general, and very stable plastic materials like polyolefins and polystyrene in particular, into more basic organic chemicals. If this sort of process was available, after the plastic was converted into simpler, more basic units, contaminants could more readily be separated from the chemical conversion products and the process of making the plastic could be started all over again. Alternatively,

these more basic chemicals could possibly be put to some other useful purpose, such as for example as fuel.

Most plastic materials, particularly polyolefins, are produced from petroleum derived raw materials. Thus, polyolefins are made by polymerizing α -olefin monomers, such as ethylene, and propylene, which in turn are made by the cracking of petroleum derived hydrocarbons. Petroleum derived hydrocarbons are the main component of petroleum derived fuels and petrochemicals. It would therefore be desirable to reconvert the polyolefins, or other plastics, into products which are more like their petroleum based starting materials in order to be able to reuse these ultimate raw materials, that is the carbon and the hydrogen content of the plastics.

There have been many attempts made in the past to convert all sorts of waste materials into petroleum type products, either fuels, lubricating oils, coke, or other products. In United States patent 1,950,811 there is disclosed a process for recovering oil and coke from oil bearing residues in combination with non-petroleum, carbonizable raw materials, such as: coal, peat, sawdust and the like, by treating a suitable feed at high temperatures of 900 to 1,000°F. In United States patent 2,412,879, a process for producing coke is disclosed wherein the feed to the coker is a mixture of conventional petroleum based coker feed and 1-10 % cellulosic material, such as sawdust, slurried therein.

In United States patent 3,909,364, a carbonizable waste, such as garbage and sanitary sludge, is mixed with coal. This mixture is then devolatilized to produce a char which is mixed with residual oil to produce a solid fuel product.

However, none of these prior processes has taken into account, or been designed to treat, plastic waste materials. Pyrolysis processes have been described as offering the possibility of conversion of some solid

organic wastes. Reference is here made to "Industrial Solid Wastes Management", pp 356-406, Proceedings of the National Industrial, Solid Wastes Management Conference, for a discussion of some of the conventional means for carrying out this desirable work.

In United States patent 4,108,730, there is disclosed a means for disposing of solid polymeric wastes, such as rubber tires, plastic wares, plastic packaging, scrap plastics, etc. The process disclosed in this reference suggests the dissolution of these high molecular weight materials in petroleum oil, preferably heavy petroleum oils such as FCC heavy cycle oil, in the absence of air but in the presence of added molecular hydrogen. It is stated that, under these conditions, the polymer feeds are dispersed and dissolved with little or no gas evolution. The resultant liquid is said to resemble crude oil and to make an excellent feed to a catalytic cracker. The cracking of this feed results in the usual array of products from a cat cracker, that is: gasoline, Diesel oil, cycle oil, and the like.

The solvents-carriers which are said to be useful in the process of this reference are very heavy, high boiling aromatic mixtures such as: FCC main column bottoms, TCC syntower bottoms, asphaltic materials, alkane deasphalted tar, coker gas oil, clarified slurry oil, anthracene oil, coal tar and mixtures thereof. Light cycle oil has also been mentioned as a possible liquefying agent. These are conventional streams which are associated with a catalytic cracker or other refinery processes, and it is quite logical that one seeking to augment the conventional feed to a catalytic cracker with plastic scrap materials would look to conventional refinery streams, particularly those associated with the unit to which the plastic scrap is sought to be fed, as a means to assist in the solubilizing of the plastic scrap materials. After all, these

conventional streams are often recycled to the cracker, or other refinery processing units anyway.

In United States patent 4,118,281, a process has been disclosed for the dissolution of organic waste materials, including garbage, plastic, paper, wood, rubber, etc. in a conventional feed to a delayed coker unit process. Thermal decomposition of this mixture under conventional coker operating conditions is said to convert this feed into oil, water, gases and coke. The waste material which is being used to augment the conventional coker feed is suitably dissolved in a refinery fraction, such as: catalytic cracker recycle, FCC main column bottoms, TCC syntower bottoms, and the like. The preferred dissolving materials for these wastes are set forth to be fresh or recycle petroleum coker feed. This patent alleges that carrying out the process described therein produces more oil than does gas phase destructive distillation or pyrolysis of organic waste materials. Of the myriad of organic waste materials which are set forth in this patent to be suitable augmenting feeds, quite a large number of plastic and polymeric materials are listed. These include polyvinyl chloride, polystyrene, polyolefins, such as polyethylene and polypropylene, polyesters, polyacrylics, various rubbers, and the like. It is noted that this patent states that the solid organic waste material being treated "does not require extensive pretreatment before admixture with the petroleum solvent".

Even with all of these disclosures in the prior art, no really good process for disposing of waste plastic materials and converting them to more usable chemicals has been evolved or has been implemented commercially. In these days of environmental awareness, such an improved process would be very desirable.

Further, it would be most desirable to be able to make useful products out of plastic waste in an economic manner. Thus, in making useful products from plastic waste or

scrap, it would be desirable to use a solvent which itself has little or no economic value.

According to the invention, there is provided a process for disposing of plastic waste material comprising
5 the steps of dissolving a hydrocarbonaceous, normally solid, plastic waste material, containing less than 10 % by weight of heteroatoms therein, in a liquid solvent which is at least a portion of an extract phase resulting from the extraction of aromatics from a petroleum fraction; and
10 feeding said plastic solution to a delayed coking unit to convert at least part of the plastic waste material to gasoline and/or distillate.

An important element of this invention is the definition of the liquid material into which the plastic
15 scrap material is dissolved prior to conversion in the coker operation. While the prior art has disclosed many conventional refinery streams as being able to effectively accomplish this dissolution of plastic materials prior to the conversion thereof into suitable products, many, if not
20 all of these prior disclosed solvents have significant value in a refinery operation. Indeed, many of these streams have a higher inherent economic value than the products of coking, even considering only the liquid products of coking.

25 It has now been found, according to this invention, that certain less valuable, conventional refinery liquid streams are particularly well suited to use as the media into which waste plastic material is dissolved. These newly discovered solvent fractions are different from those
30 materials which have heretofore been disclosed as possibly useful for the dissolution of plastic materials. They are also of substantially lower economic value than coker products, and therefore, in contrast to the solvents proposed in the prior art, the conversion thereof along
35 with the plastic waste actually increases their value to the refinery.

Specifically, highly aromatic extract streams have been found to be particularly well suited as media into which plastic materials, particularly substantially hydrocarbon polymeric materials, will dissolve. These solvents of this invention can be characterized as having:

- an API gravity less than 15, preferably less than 10, most preferably 5 to 10;
- a specific gravity of at least 0.95, and preferably a specific gravity of at least 1;
- a molecular weight of at least 200, and preferably at least 350;
- a flash point of at least 90°C (200°F), and preferably at least 150° (300°F);
- a boiling point distribution and range which is relatively narrow, but is sufficiently high to prevent substantial vaporization in the coker main distillation column and will insure that the solvent stream does not substantially solidify under the conditions prevalent in the coker and in the coker main column, more particularly a 5% distillation point of at least 315°C (600°F), preferably at least 343°C (650°F), and a 95% distillation point that is not substantially higher than 590°C (1100°F); and
- a sulfur content which is high enough to make the selected solvent a stream of little economic value, that is at least 3%wt, preferably at least about 3.5%wt.

In particular, it is well known that several processes exist in which various refinery streams are extracted in order to "purify" a product or to make it better suited to whatever its intended use might be. One example of this type of purifying process, in which aromatics are conventionally removed from another stream in order to improve the quality of the remaining stream, is extraction of the aromatics from lube oil base stocks. It is well known to extract the aromatics out of lube oil base stocks, for example with furfural or other extractants, in order to render the base stock more paraffinic, which therefore

makes it better suited to use as a lubricating oil. The extract phase of this process is highly aromatic in nature, and is referred to as furfural extract, or furf extract.

Many of the solvents which are used for these
5 extractions are very well known chemicals which are widely used commercially. They include, among others, furfural, phenol, sulfolane, and dimethyl formamide. These conventional extraction processes create two phases, one more highly aromatic extract phase and one more highly
10 aliphatic, usually more paraffinic, raffinate phase. In many of these operations, such as in treating lube oil base stocks, the more highly paraffinic raffinate phase is the more desired and is a much more valuable product for lube oil use. The other, more highly aromatic extract phase, is
15 less desirable and is often simply recycled back into the pool of refinery streams for further use in making heavier fuels or other products, which are usually substantially less valuable than the lube oil base stocks which come from the raffinate phase.

20 It has been found that various plastics, particularly those based on styrene polymers, are sufficiently soluble in lube oil extract phases, such as furfural lube oil extract, that such solutions can be directly fed to the coker. The liquid products resulting from coking feed
25 streams with the added plastic waste include incremental yields of gasoline of good octane quality as well as increased amounts of higher boiling products, such as middle distillate range oils. The composition of the liquid products will depend on the chemical composition of the
30 added plastic, with polystyrene giving a high octane gasoline of aromatic character whereas polyolefins, such as polyethylene and polypropylene, give relatively more middle distillate. The plastics are, however, readily converted to the desired liquid products without a major increase in the
35 amount of coke produced especially with polyolefins, such as polyethylene and polypropylene.

Particularly preferred extract fractions for use in this invention are: heavy vacuum distillate furfural extract, bright stock extract, and light vacuum distillate furfural extract. These are the aromatic portions of vacuum distillation fractions from crude oil which have been suitably extracted. These fractions have molecular weights of 300 to 600, and have aromatic contents greater than 80%wt.

These solvents differ from those refinery streams which have been sought to be used in the past for this service in many ways. Catalytically cracked stocks, as exemplified by FCC-CSO (Fluid Catalytic Cracker Clarified Slurry Oil), which has previously been suggested, usually contains at least about 60% of its carbon resident in aromatic rings. In contrast, the distillate extracts of this invention contain 39 to 45% of their carbon resident in aromatic rings. Straight run stock, that is fractions which have not been cracked, such as LVGO (light vacuum gas oil) has about 21% of its carbon atoms resident in aromatic rings. Thus it should be clear, from these numbers, that the straight run distillate fractions contain less aromatics than do the extract distillate fractions of this invention, and that the aromatics in the extract distillate fractions being used in this invention have more side chains than do the aromatics which result from cracking. The distillate extract fractions which are used in this invention often have API gravities of 9 to 12, which is a reflection of the increased number of side chains on the aromatic nuclei thereof. It has been found that aromatic extract fractions having API gravities of 5 to 15 are well suited to use as solvents in this invention. Both cracked stocks boiling in the distillate range, and straight run fractions boiling in this range have API gravities which are outside this range, either because their aromatic content is too low, or because their proportion of carbon in aromatic rings is too high. These distinctions are

important in defining the solvent phase into which the scrap plastics are dissolved as compared to the fractions which have been proposed by the prior art.

As has been noted above, most plastic materials are composed of relatively long chains which are often hydrocarbon in nature. In the case of most polyolefins, these chains are aliphatic. In some other cases, like polystyrenes and polyesters, these polymer chains may be long, but they have many aromatic or other, heterogeneous groups within their chains.

It has been found, according to this invention, that when suitable plastics materials are dissolved in a suitable solvent as aforesaid, and the solution is fed into a delayed coker which operates in an otherwise conventional manner, the product of the operation of the delayed coker is substantially different from, and superior to, the product which would otherwise be made in this same coker operation in the absence of the extract solvent/plastic portion of the feed. For example, when the dissolved plastic has a high proportion of styrene based polymer, preferably polystyrene, the coker naphtha has a substantially higher octane number than it would otherwise have. In the case of solutions of plastics which are derived from α -olefins, it has been surprisingly found that there is a substantial reduction of foaming in the coker drum itself, which is a most desirable and unexpected attribute and permits the production of increased amounts of coke in a run. Further, where the α -olefin is propylene, the delayed coking of a feed containing such propylene containing polymer dissolved in an aromatic extract phase results in a naphtha which is very high in iso C-₁₂S, a fraction which has substantial use in producing commodity chemicals.

The following Tables I-III show the physical and chemical properties of some petroleum fractions, some of which are well suited to use as a solvent in this invention

-10-

and some of which are not. Table IV shows the solubility characteristics of different plastics in different petroleum refinery fractions. Table V shows the products of pyrolyzing various plastics without first dissolving such
5 in a suitable solvent and then subjecting them to refinery coking.

TABLE I. SOLVENT PHYSICAL PROPERTIES								
	LVGO	L. FURF EXT.	FCC LCD	FCC CSO	COKER LGO	COKER HGO	Bright Stock Extract (BSE)	Heavy Furf Extract (Mobil- sol "30")
GRAVITY, °API	24.0	9.9	18.5	-3.1	33.8	18.6	11.8	9.1
SPECIFIC GRAVITY, 60/60	0.9098	1.0009	0.9433	1.1024	0.8560	0.9425	0.9872	1.0062
DENSITY, 70°C	0.8691	0.9656	0.9042	1.0658	0.8168	0.9019	0.9636	0.9690
MOL. WT.	331	299	195	284	196	312	587	424
BROMINE NUMBER	3.44	6.70	8.65	16.98	32.84	15.83	6.14	1.09
POUR POINT °F	75	30	10	40	-35	85	95	85
FLASH POINT, °F (D93)	CANC.	CANC.	180	243	151	246	397	333
CCR, wt%	0.03	0.01	<0.01	7.46	0.02	0.47	4.63	2.12
ANILINE POINT, °F	170.8	55.3	N/A	N/A	N/A	N/A	145.5	110.5
RI @ 70°C	1.4861	1.5499	1.5209	DAR K	1.4533	1.5084	1.5343	1.5487
KV @ 149°C	-	-	-	-	-	-	-	-
KV @ 100°C	4.078	5.771	1.271	14.69	1.048	4.439	60.59	25.06
KV @ 54.4°C	(13.3)	(28.2)	2.513	173.9	1.871	15.33	-	-
KV @ 40°C	22.66	60.80	()	()	-	-	3955	965.4

TABLE II. SOLVENT CHEMICAL PROPERTIES								
	LVGO	LI. FURF. EXT.	FCC LDD	FCC CSO	COKER LGO	COKER HGO	Bright Stock Extract (BSE)	Heavy Furf. Extract (Mobil- sol "30")
HYDROGEN, wt%	12.55	10.11	10.49	7.71	12.79	11.73	10.33	9.96
SULFUR, wt%	2.1	4.8	2.4	3.7	1.45	2.3	3.8	3.9
NITROGEN, ppm	600	1600	3300	2600	-	2200	2200	3000
BASIC N, ppm	185	447	51	158	390	963	512	735
Ni, ppm	<.15	<.15	<.15	0.15	<.15	<.15	0.7	0.5
V, ppm	<.05	0.05	<.05	0.30	<.05	<.05	0.75	0.6
Fe, ppm	<.05	<.05	<.05	3.6	<.05	0.05	0.15	0.35
Cv, ppm	<.05	0.05	<.05	<.05	<.05	<.05	2.1	1.8
Na, ppm	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
ASPHALTENES, C ₃ I, wt%	0.23	0.39	-	-	-	-	0.09	0.09
% AROMATICS	-	88.2	-	85.1	CANC.	51.4	82.91	84.8
CARBON-IN- AROMATIC RINGS	21	45	48	60	-	-	24	39

TABLE III. SOLVENT DISTILLATION PROPERTIES								
	LVGO	Light FURF. EXT.	FCC LCD	FCC CSO	COKER LGO	COKER HGO	Bright Stock Extract (BSE)	Heavy Furf. Extract (Mobil- sol "30")
IBP	603	609	287	466	283	409	707	654
5	661	663	445	629	383	583	862	729
10	679	680	474	684	400	630	906	774
20	706	706	517	742	424	672	951	845
30	727	727	532	775	453	702	981	894
40	748	747	558	800	482	730	1005	924
50	767	767	585	823	509	760	1025	946
60	786	787	616	848	533	790	1043	964
70	805	807	649	879	558	823	1060	982
80	825	828	682	917	587	862	1083	1001
90	849	853	718	978	618	911	1107	1028
95	866	871	744	1047	636	946	1122	1049
EP	910	917	805	-	692	1028	1152	1095

TABLE IV. DISSOLVING PLASTICS IN REFINERY STREAMS Temperature Range: 300 - 400 ° F (Nominal)			
	Maximum Concentration, wt%		
	PS	PP	LLDPE
FCC CSO	22	<5	22
FCC LCO	48	32	33
FURF Extracts	46	30	23
Coker HGO	30	40	33
Vac Resid	0.4	6	17
LVGO	<5	<25	28

TABLE V. SUMMARY OF PLASTICS COKING DATA						
	Resid	PS	LLDPE	LDPE	HDPE	PP
C ₃ -, wt%	7.2	1.1	8.0	7.2	9.7	10.9
C ₄ -380 Naphtha, Vol%	24.3	57.2	28.1	35.6	39.7	67.7
380-650 LGO, Vol%	25.0	23.7	39.3	39.3	38.4	29.2
650-850 HGO, Vol%	18.4	12.0	29.4	26.4	22.2	9.3
850°F + Bottoms, Vol%	9.1	6.8	9.0	5.9	8.3	2.4
Coke, ywt%	27.3	9.0	0.3	0.2	0.5	0.2
Total C ₄ +Vol%	76.8	99.7	105.8	107.2	108.6	108.6

In the practice of this invention, the polymeric waste material is suitably admixed with the aromatic extract solvents described herein until a substantial amount of plastic is dissolved, suspended, and/or dispersed therein.

5 Operating at elevated temperatures is often helpful in increasing the amount of plastic which can be dissolved in the solvent system of this invention. Suitable dissolution operating temperatures are 10 to 325°C (50 to 600°F), preferably 150 to 230°C (300 to 450 °F).

10 Dissolution of plastic materials into a suitable aromatic extract solvent can be accomplished in a batch or a continuous operation as needed. As is common in any solubilizing operation, dissolution can be assisted by

increasing the surface area of the plastics material. This can be accomplished by comminution, such as by grinding or shredding.

According to this invention, it is preferred to limit the plastic material, as much as possible, to hydrocarbonaceous plastics such as poly(aliphatic)olefins, polystyrenes, and substituted polystyrenes, as well as copolymers which are predominantly hydrocarbonaceous in nature. Small proportions of other plastics can be tolerated by this process but are not preferred. Suitably, less than 10% of the plastic scrap feed to this process can be non-hydrocarbonaceous, e. g. halogens, nitrogen, sulfur and oxygen.

Industrial plastic scrap is not generally differentiated according to the chemical nature of the plastic material. However, the halogenated plastics, such as polyvinyl chloride and polyvinylidene chloride, and the oxygenated plastics such as polycarbonates and polyesters, usually have a higher density and may therefore be separable by suitable mechanical means, such as for example centrifugation, either by themselves or suitably suspended in a liquid, such as the aromatic extract solvents which are selected according to this invention. The halogenated plastic materials tend to decompose at relatively low temperatures of 90 to 200°C (200 to 400 °F). Therefore, the conditions which are conducive to dissolution of the plastics in general are also conducive to the decomposition of polyvinyl chloride, causing HCl to be driven off. Since HCl is highly corrosive and is therefore detrimental to most downstream processing activities and equipment which will see the plastic solution, it is most desirable to remove this material from the dissolved plastic and to separately collect and dispose of it.

As aforesaid, downstream processing of the dissolved plastic is by means of a delayed coking operation. The dissolved plastic solution is suitably fed into the coker

main column fractionator along with other, more conventional feed streams.

In order to bring the feedstock up to the required temperature and to conserve process heat, the feedstock is usually charged near the base of the same fractionator tower which receives the overhead volatile components which are driven off the coke drum. The feed to the furnace is taken from the bottom of the fractionator or "combination" tower, and the products of the coking process, including heavy coker gas oil, light coker gas oil and coker gasoline are removed from the higher levels in the tower. The use of the tower bottoms as the feed for the coker furnace has three main objectives. First, heavy fractions which are recycled through the unit will be further cracked to lower boiling products which have greater utility even though the yield of coke ("coke make") is increased by this recycling; second, the metals content of the products is reduced as the coke make increases because the metals tend to accumulate in the coke; third, use of the recycle as diluent tends to reduce coking in the furnace. The addition of the dissolved plastics material to the coker operation improves the liquid yield. Normally, the liquid yield from a coker, being highly unsaturated, is very unstable so that it is difficult to find economically attractive uses for it. The present process offers the potential of producing increased amounts of high octane gasoline and good quality distillate, depending on the choice of plastic used in the process.

In a preferred practice of this invention, the plastic scrap material is dissolved in a suitable solvent as aforesaid, such as for example the highly aromatic furfural extract from a lube unit, and the solution is fed to the fractionator of the delayed coker unit. It has been found that the plastic solute and its aromatic extract solvent are high enough boiling that they stay in the liquid phase within the coker main fractionator. Thus they become part

-17-

of the bottoms of the fractionator and are fed to the coker unit as part of the otherwise conventional feed from the main column bottoms. This is economically most advantageous since the solvent generally is of little economic value. Its conversion to lighter products, along with the plastic scrap solute, in the coker substantially increases its economic value.

Thus the extract phase, including the solvent and its content of aromatics and dissolved plastic scrap, become part of the nominal 454°C+ (850 F+) unconverted heavy fraction which is normally separated out in the coker fractionator and fed (recycled) to the delayed coker process, specifically through the furnace and thence into the coke drums. Under the conditions of delayed coking, the dissolved plastics and the highly aromatic extract solvent thermally crack along with the remainder of the feed to the coker, to form more valuable, lower molecular weight fractions, and become part of the coker naphtha and distillate. Surprisingly, when the coker feed is augmented according to this invention, these liquid products, instead of being poor streams in need of other processing, become excellent additions to the gasoline and distillate pools.

It is considered to be one aspect of this invention to subject the plastic scrap solution to filtration in order to remove any undissolved materials which have been carried along with the solution. These solids may be dirt, inorganic fillers which were present in the plastic, catalyst residues, and even perhaps some undissolved portions of the plastics themselves, such as highly crosslinked gels. Feeding such solid materials to the coker would be detrimental to the operation of this unit which is not designed to handle solid feed materials, or solid products. This filtration is a preferred aspect of this invention which is desirably, but not necessarily used.

It should be noted, however, that where the plastic scrap contains a substantial proportion of halogenated plastics, the dehalogenated product of such plastics is rather gummy, and therefore is liable to foul a filtration system. It has therefore been found to be preferable to feed such dissolved plastics containing such products directly into a coking drum downstream of the furnace.

The invention will now be more particularly described with reference to the accompanying drawing which is a schematic diagram of a delayed coking process according to one example of the invention.

Referring to the drawing, the scrap plastic material 8 for feeding to the coker according to this invention is comminuted into very fine particles and fed to a holding vessel 10, which may be suitably agitated in a known manner. A highly aromatic extract solvent 12 is also fed to this vessel and the two mixed for a time sufficient to dissolve at least substantial proportions of the plastic scrap in the solvent to form a solution 14 which is, in turn, fed to the main fractionator tower 16 of an otherwise conventional refinery coker operation. The other refinery streams which are intended to be processed in the coker are accumulated and fed into the tower as feed 17, typically at a temperature of about 200°C. The dissolved plastic solution 14 is mixed with the feed 17 and the liquid products of coking 18 which come off the coke drums 20, typically at a temperature of 440°C at 500kPa, in the lower section of the fractionator tower 16. The mixture of oils in the tower is fractionated into its component materials, which include the liquid products of coking such as naphtha 22, light coker gas oil 24 and heavy coker gas oil 26, as well as the bottoms liquid feed to the coker 28. Stream 28, which is fed to the coker drums 20, is suitably heated, conventionally by means of a furnace 29, before being fed to the coker drums. Steam is fed into the stream 28 through line 30 at a point where the stream is typically at a

temperature of 260°C (500°F) before being heated in the furnace to a typical coking temperature of 490 to 500°C (910 to 930°F) at a pressure of 400 kPa (45 psig). Wet gas and sour water are removed from a tower overhead
5 accumulator 33 through lines 31 and 32 respectively. Coke is withdrawn from the drum bottom at the end of each coking cycle, as indicated by the arrows.

The solutions of plastic scrap which are used according to this invention produce a solid as well as
10 liquid coker product which is augmented to increase its quantity and quality as a function of the amount of plastic scrap which has been fed thereto. This process shows an improvement in the amount of scrap plastic which can be converted in the conventional delayed coker when using the
15 specific group of solvents defined herein, as compared to what is achievable by using solutions of plastics in solvents which have been disclosed in the past.

CLAIMS

1. A process for disposing of plastic waste material comprising the steps of dissolving a hydrocarbonaceous, normally solid, plastic waste material, containing less than 10 % by weight of heteroatoms therein, in a liquid solvent which is at least a portion of an extract phase resulting from the extraction of aromatics from a petroleum fraction; and feeding said plastic solution to a delayed coking unit to convert at least part of the plastic waste material to gasoline and/or distillate.

2. A process as claimed in claim 1 wherein the delayed coker unit includes a coker drum and a fractionating zone which receives liquid product from the coker drum and resolves said liquid product into at least one overhead stream comprising gasoline and/or distillate and a bottoms stream which is recycled to the coker drum, and wherein said plastic solution is fed to the fractionating zone so that at least part of the solvent is removed as an overhead stream and the plastic waste is fed to the coker drum in the bottoms stream.

3. A process as claimed in claim 1 or claim 2 wherein said extract phase solvent has the following properties:

- an API gravity less than 15;
- a specific gravity of at least 0.95;
- a molecular weight of at least 200; and
- a flash point of at least 90°C (200°F).

4. A process as claimed in any preceding claim wherein said solvent has a 5% distillation point that is at least 315°C (600°F) and a 95% distillation point that is not substantially higher than 590°C (1100°F).

5. A process as claimed in any preceding claim wherein said solvent has a sulfur content of at least 3%.

6. A process as claimed in any preceding claim wherein the API gravity of said solvent is less than 10.

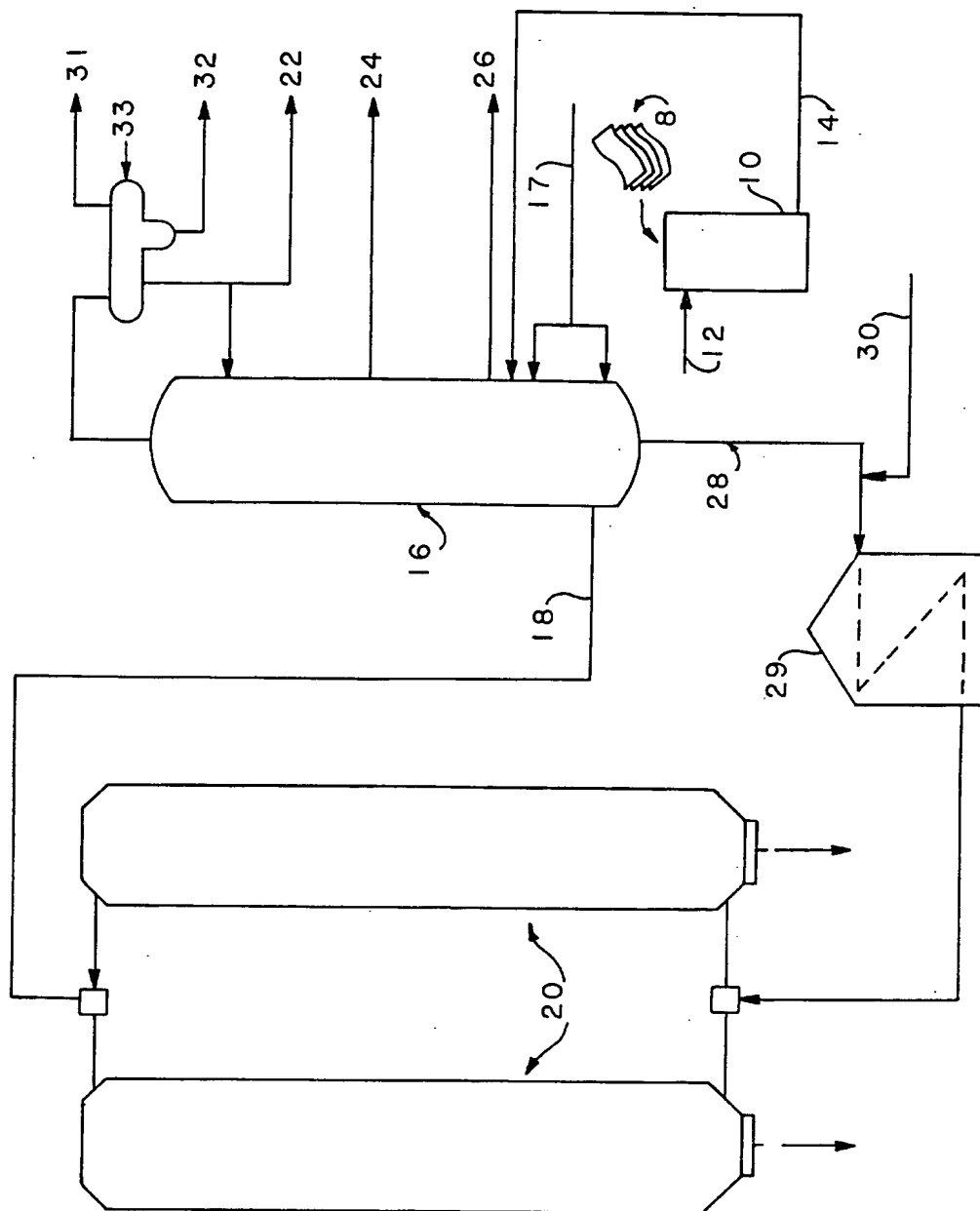
7. A process as claimed in any preceding claim wherein the API gravity of said solvent is 5 to 10.

8. A process as claimed in any preceding claim wherein said solvent has a flash point of at least 150°C (300°F).

9. A process as claimed in any preceding claim wherein said dissolved plastic comprises a styrene polymer.

10. A process as claimed in any preceding claim wherein said dissolved plastic comprises an aliphatic olefin polymer.

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SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/13426

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : C10G 9/14

US CL : 208/131

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 208/131

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

SEARCH TERMS: PASTIC WASTE AND DELAYED COKING

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,617,514 (MARLAR) 02 NOVEMBER 1971, COL.2, LINES 33-75	1-10
Y	US,A, 4,118,281 (YAN) 03 OCTOBER 1978, COL. 2, LINES 39-66	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X*	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
E earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*A*	document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means		
P document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

23 FEBRUARY 1995

Date of mailing of the international search report

24 MAR 1995

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